rapid reconnaissances like those now carried on by the War and Interior Departments; and, lastly, surveys for the parcelling of public land.

2. Having regard to the enormous area of territory yet to be explored and surveyed, its vast mineral wealth, its agricultural and pastoral resources, its stores of timber, its capabilities of soil, the Academy believes that the best interests of the country require that, for purposes of intelligent administration, a thorough knowledge must be obtained of the geological structure, natural resources, and products of these regions. It therefore recommends the establishment of an independent organisation, with a Director appointed by the President, to be placed under the Department of the Interior, and to be styled the United States Geological Survey. The duties of this Survey would include the investigation of the geological structure and of the economic resources of the public domain.

This consolidation of all the surveying work, sanctioned and paid for by Congress, would of course involve radical changes in some of the Departments. The Bureau of Engineers, in particular, would be required to give up all surveying work except what might be necessary for merely military purposes, and for such engineering operations as the rectification of rivers, irrigation and drainage, reclamation and protection of alluvial land. The various geographical and geological surveys west of the 100th meridian, now carried on by the War and Interior Departments, would be discontinued, though of course they would, in some cases, be resumed under the proposed new organisation.

Three distinct branches of the public service are thus proposed to be established for dealing with the public domain:—First, the United States Coast and Interior Survey, charged with the accurate mapping of the country; second, the United States Geological Survey, for the investigation of the geological structure and natural resources of the domain; third, the Land Office, having charge of the subdivision and sale of the public lands, and entitled, therefore, to call upon the Coast and Interior Survey for all necessary surveys and measurements, and upon the Geological Survey for all information as to the value and classification of lands.

Considerable liberty is proposed to be given to the chiefs of the two surveys as to the nature and extent of their publications. They are each to present an annual report of operations, and provision is to be made for the issue of such maps, charts, reports, discussions, treatises, and other documents as they may deem to be of value. Most liberal provision is likewise recommended to be made for the distribution of the reports of the Surveys. Besides the number of copies required by Congress for its own use, 3,000 copies are proposed to be published for scientific exchanges by the heads of the surveys and for sale. The special reports are to be issued in uniform quarto size, liberty being left to each director to choose such a form for his chartographic publications as shall combine the most effective style with the greatest economy. All specimens collected by the two surveys when no longer required for the investigations in progress are to be transferred to the National Museum.

Such in brief are the recommendations made by the National Academy in response to the requirement of Congress. That they are eminently wise and thoroughly practicable must be freely admitted by all capable of forming an opinion on the subject. It is simply impossible that things can go on as they are. Each one of the Surveys now in progress has done good work; several of them most admirable work. But work as good could be got with less labour and at less cost. This cannot be effected without combination; and the Academy has pointed out with great clearness and judgment how the combination may be achieved. It is not to be expected that changes of this kind can be carried out without irritating some of the individuals whose position is thereby affected. But save the severance of the Bureau of Engineers from all control of the surveys there need be comparatively little disturbance of the work now going on. Dr. Hayden, who with his staff has done so much in recent years for American geology, would doubtless take a high command under the new system; and it may be hoped that his position will be so secured as to enable him to devote his whole time to the scientific work for which he has shown himself to be so admirably qualified. Mr. Powell and his colleagues might continue their interesting and important Colorado investigations. To Mr. Clarence King fresh fields of research lie open where he may win laurels as bright as those he now wears. To all these officers in so far as they have at present geographical and topographical work to carry on, the allocation of all such duties of mensuration to a special geodetic survey should be a welcome relief, as it will set them free for their own special investigations. The Academy in its Report contemplates the possibility of officers, both of the army and navy, being desirous to volunteer for employment in these surveys, and recommends that when their services are not otherwise required they should be permitted to take part in the general survey. In this way a connection with the engineers might be re-established, and we may be sure that every engineer officer of capacity would be welcome, and would take a good position under the Department of the Interior.

The Report of the Academy, on being presented to Congress, was, on the 2nd ultimo, referred to the Committee on Appropriations, and ordered to be printed. As Congress rises at the beginning of March, some action may be expected to be taken on the matter before that date. It will be a subject for sincere congratulation among all well-wishers of American science and general progress, should the decision be in the direction pointed out by the National Academy of Sciences.

ARCH. GEIKIE

KERNER'S "FLOWERS AND THEIR UNBIDDEN GUESTS"

Flowers and their Unbidden Guests. By Dr. A. Kerner. With a Prefatory Letter by C. Darwin, M.A., F.R.S. The translation revised and edited by W. Ogle, M.A., M.D. (London: C. Kegan Paul and Co., 1878.)

THIS charming book is the record of an extension, in a somewhat different direction, of the researches of Darwin, Hermann Müller, and others, on the assistance rendered by insects in the cross-fertilisation of flowers. Attention has hitherto been directed almost exclusively to the contrivances by which insects, while feeding on or sucking the honey from the nectary, are almost compelled to be the involuntary agents in the transmission of the pollen from the anther to the stigma in a different flower of the same species. In almost all cases, however, it is only a comparatively small number of insects that would be adapted, by the size of their body, the length of their proboscis, and other points in their structure, to insure the cross-fertilisation of any particular species of flower. It is obvious that the visits of all other insects, which would consume the honey without aiding in the transmission of pollen, not only can be of no advantage, but must be positively injurious to the plant, by preventing the visits of the useful insects. It is this point that Prof. Kerner has studied with great industry and acumen; and he has compiled a number of most interesting illustrations of the contrivances presented in the structure of the flower, which not only force the useful insects to enter it in the particular way which shall be of most advantage to it, but keep out all others.

Dr. Kerner is dissatisfied with the vague use in botanical works of the words "self-fertilisation" and "cross-fertilisation," and proposes to substitute them by others which shall have a more definite meaning. He uses the term "autogamy" for the fecundation of a flower by the pollen from the andrœcium of the same flower; "geitonogamy" for the fecundation of a flower by pollen from other flowers on the same plant; and "xenogamy" for fecundation by the pollen from a flower on another plant; while the term "allogamy" would include the last two as contrasted with autogamy. The only previous attempt at a strict scientific terminology with which I am acquainted is by Delpino,[1] who distinguishes four kinds of fecundation: homoclinic homogamy, fecundation by pollen from the andrœcium of the same hermaphrodite flower; homocephalic homogamy, fecundation by pollen from the andrœcium of a different flower of the same inflorescence; monoicous homogamy, fecundation by pollen from the andrœcium of a flower belonging to a different inflorescence on the same plant; and dichogamy, fecundation by pollen from the andrœcium of a flower on a different plant. Prof. Kerner's terms will at all events be admitted to have the merit of being the simplest, and will probably be generally adopted in future.

It may be stated as a general rule that, while the visits of winged insects are beneficial, those of wingless insects are mostly injurious, since these consume the nectar without immediately afterwards visiting another flower so as to favour allogamy. Hence the majority of the contrivances which Kerner describes are for the purpose of excluding from the flower wingless insects, and in particular ants, the great enemies of flowers, and the aphides which attract ants. The flora of the mountain valleys of the Tyrol furnishes almost inexhaustible material for working out a problem of this kind; and of this material Dr. Kerner, who holds the position of professor of botany in the University of Innsbrück, has availed himself to the full.

Simplest among the contrivances for excluding useless, while admitting useful insects, are the more or less dense collections of hairs which cover up the entrance to the nectary in so many flowers, rendering the road inaccessible to very small insects, while presenting no obstacle to larger insects which can brush them aside or pierce them with their proboscis. Beautiful instances of this arrangement are described and illustrated in the work before us in the cases of *Anchusa arvensis*, *Lonicera alpigena*, *Veronica chamædrys* and *officinalis*, *Malva rotundifolia*, *Monotropa hypopitys*, *Menyanthes trifoliata*, and many others. Sometimes these coverings take the form of appendages to the corolla which protect the openings to the nectaries with flaps, as in *Gentiana nana* and *Soldanella alpina*. Again, access to the nectary by small insects is often prevented by the parts of the flower being bent, dilated, or crowded together, the same contrivances resulting also in forcing those insects which are useful to enter and leave the flower in such a way as to be of the greatest service in the transmission of pollen. Thus, in *Nigella* each spoon-shaped petal is hollowed out into a kind of pit, into which nectar is secreted in abundance. At the point where the handle of the spoon is continuous with the bowl the petal gives off an excrescence which covers in the whole nectar-cavity like a lid, closing it completely, and no insect can possibly rifle the nectar unless it be strong enough to lift up this lid. Ants are by this means entirely excluded, while the common honey-bee is able to lift the lid with ease, in doing which he must inevitably rub against either anther or stigma, according to the stage of development of the flower. In his "Entdeckte Geheimniss der Natur" (1793) Sprengel describes, with wonderful accuracy, the proterandrous flower of *Nigella*, and the mode in which the structure of the various parts secures allogamy by the agency of bees. He observed the flaps over the nectaries, but suggests no other interpretation of them than to serve as a protection against rain. A similar occlusion of the nectary against small insects is effected in *Cynoglossum* by the outgrowths from the mouth of the corolla, in *Campanula* and *Phytemna* by the strap-shaped lower parts of the filaments, in *Ranunculus glacialis* and many Mesembryanthemaceæ and Cactaceæ by the mass of crowded filaments, in *Pentstemon* by the fifth barren stamen.

These protective and prohibitive arrangements are frequently placed, not inside, but outside, the flower, one very common form being the hairs, glandular or not, with which the calyx, bracts, or upper part of the stem are so frequently clothed; and the purpose is still more effectively answered when the glandular hairs or the stem itself exude a viscid secretion. In such plants as *Cistus ladaniferus*, *Listera ovata*, *Geranium sylvaticum*, *Euphrasia viscosa*, *Lychnis viscaria*, and a large number of species belonging to the orders Caryophyllaceæ, Saxifragaceæ, Labiatæ, and Scrophulariaceæ, it is almost impossible for the flower to be visited by any but winged insects. Prof. Kerner believes that the numerous insects which are found adhering to the viscid peduncles and stems of these plants are not digested so as to serve the plant with nutriment, but that the object of their destruction is simply to prevent their reaching and rifling the nectary. An explanation is thus offered of the well-known fact that the same species will frequently assume a hairy habit when growing on land, and a glabrous habit when growing in water, water-plants being almost invariably destitute of hairs. An admirable instance of this law is furnished by *Polygonum amphibium.* Kerner shows that the nectaries of this plant are entirely unprotected against the incursions of "unbidden guests." When growing in water this is no disadvantage, because none but flying insects can reach the flower. But when growing on land the nectar would be liable to be rifled by small creeping insects that would carry it away without performing any compensating service to the plant, and in such circumstances an innumerable quantity of glandular hairs make their appearance on the epidermis of the leaves and stem which effectually bar the way against the unwelcome visitors. "If the ground on which a *Polygonum* has grown for years in dryness, so as to have become covered with these trichomes, again be flooded, and the stems and peduncles again therefore be encircled with water, the trichomes with their viscidity disappear, and the epidermis again becomes smooth and even." I find this statement difficult to reconcile with a dictum laid down further on in the volume—and, as it appears to me, laid down hastily without sufficient warrant—that "the so-called process of 'adaptation' is never a direct one, never comes simply in response to a want. In other words, external conditions can never occasion an inheritable change of form, whether advantageous or the contrary, can neither determine the development of an organ nor its abortion."

---

[1] *Nuovo Giornale Botanico Italiano*, vol. viii., 1876, p. 146.

Although glandular hairs or viscid secretions are the most common contrivances for preventing the access to the nectary of useless insects, they are by no means the only ones. The same object is attained by the prickles which cover the upper portion of the stem or the peduncles, and the spines into which the involucre of many Compositæ is converted. The waxy or even the glabrous epidermis in some plants prevents creeping insects from reaching the flowers. Even the latex or milky juice of such orders as Euphorbiaceæ, Convolvulaceæ, and Cichoriaceæ is pressed into the service. Kerner placed various kinds of ants on plants that were full of milky juice, such as the common lettuce. No sooner did they reach the uppermost leaves or peduncles than their feet cut through the tender epidermis of those parts, causing the latex to flow, which immediately glued the little animals to the stem so that they were totally unable to escape, and most of them miserably perished. The extra-floral nectaries, on the leaves or other parts of the plant, of *Viburnum tinus* and *opulus*, *Impatiens bicornis*, and many Leguminosæ, serve a similar purpose of diverting creeping, but not winged insects from the flower; since an insect crawling up the stem would always reach these secretions of nectar before the flower.

Some plants have to be protected from animals of a larger size, ruminants and other herbivorous quadrupeds. Some are altogether so protected by their prickly stem and leaves, or by the nauseous or unwholesome secretions of their tissues. But unpalatable secretions are much more common in the petals than the leaves; and with many plants the leaves are eagerly devoured by grazing animals or by caterpillars, while the flowers are left entirely untouched. While the comparatively large size of the flowers of alpine plants no doubt has for one object the attraction of hymenoptera and lepidoptera from a distance, the large area occupied by them in comparison to the leaves—the very character which renders many of them such favourite ornaments of our rockeries and flower-beds—doubtless also serves to protect them from destruction by goats and other mountain quadrupeds.

Space does not allow me even to refer to many other singular and interesting relationships pointed out by Prof. Kerner. It is of course quite possible that further examination may modify some of his conclusions in their detail. For example his belief that the main object of the viscid secretion on the leaves of *Pinguicula* is to prevent the access of creeping insects to the flower hardly appears consistent with the fact that most species of the genus flower early in the spring, while the secretion continues its activity through the summer and autumn. But the book is a perfect mine of original research, and is indispensable to all who are interested in the many problems connected with the fertilisation of flowers.

Dr. Ogle's translation is, with but little exception, easy and graceful. His editorial notes are useful, and he has adopted the praiseworthy practice—since the work is intended for non-scientific as well as for botanical readers—of explaining in foot-notes the meaning of technical terms used by the writer. In a future edition this practice might with advantage be extended. Such a term as "epiblasteme" does not carry its own meaning with it; and even botanists not well read up in recent literature would be puzzled by it. Or perhaps a glossary would be more useful. Three large-sized lithographic plates crowded with detail add greatly to the lucidity of the descriptions.

ALFRED W. BENNETT

FLAMMARION ON DOUBLE STARS

Catalogue des Étoiles Doubles et Multiples en Mouvement relatif certain. Par Camille Flammarion. (Paris: G. Villars, 1878.)

IN this compact volume of less than two hundred octavo pages M. Flammarion has collected together the large number of measures of double and multiple stars, exhibiting change in the relative positions of the components, which have been made by various observers since the time of the father of double-star astronomy, Sir W. Herschel. Those who have been occupied in the study of this branch of the science will be well aware of the difficulty and trouble attending the preparation of a complete history of any of these objects from the measures being scattered through a great many astronomical works, some of them not always easily accessible, and M. Flammarion has not yet attached his name to any volume which is likely to compare with the present one in usefulness.

The author's authorities are about one hundred in number, and he refers to them by abbreviations, a list of which precedes his catalogue, but it is to be regretted that he has not also prefixed the titles of the volumes whence the various measures have been taken, and the more so as there are indications that the original authorities have not been invariably consulted. Thus a number of Capt. Jacob's measures made with the Lerebours equatorial at Madras and published in the first catalogue in the volume of Observations 1848-52, are omitted in M. Flammarion's lists, though he has others which appear in the second catalogue in the same volume, formed after the substitution of a new object-glass. In the case of π Lupi, where he regrets "que les étoiles australes soient